Bicycle Collisions in the District of Columbia: 2000-2002

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By

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Abstract

On average, 271 bicycle crashes are reported to the Metropolitan Police Department each year between 1997-2002 in the District of Columbia, representing nearly 2 percent of crashes by all transportation modes. This study of bicycle collision data for the years 2000-2002 represents one effort to improve the safety of District cyclists. Crash studies investigate past events to predict future trends with the goal of reducing the underlying factors that contribute to collisions. Most often this information is used to identify high-risk areas for evaluation and modification, for improving educational and safety programs, and targeting these programs to vulnerable groups.

The report begins with a summary of key findings from the 2000-2002 police crash data, and its implications for planning and policy. Next, information is presented on bicycle collision types, location (including GIS mapping), contributing circumstances, and profiles of the involved bicyclists and motorists. The time of the crashes is analyzed by hour, day, month, and season, and traffic conditions, traffic controls, road type, weather, and lighting are also examined. Following the summary of findings, the report compares significant similarities and differences between past bicycle collision studies and the 2000-2002 data. The report concludes with a discussion of data limitations and recommendations for next steps.

Some key findings of the 2000-2002 study include that (1) among the District's eight political wards, wards 1 and 2 had the highest percentage of bicycle crashes (18.4 and 37.3 percent respectively); (2) cyclists were only slightly more likely than motorists to be at fault in a crash; (3) the vast majority—85 percent—of the cyclists involved in crashes were male; (4) cyclists between the ages of 25 and 34 had the highest involvement in bicycle collisions of any other age group; (5) motor vehicles from outside of DC were involved in 55 percent of bicycle collisions; and (6) Thursday had the highest frequency of bicycle collisions, while 42 percent of crashes occurred during the weekday morning and evening rush hours. These findings led to a number of significant implications for addressing data limitations found and taking next steps in planning and public policy. Twenty recommendations for next steps are categorized into four areas: (1) improved information; (2) additional GIS research and analysis; (3) enforcement and engineering; and (4) training, education, and public involvement.

Introduction

From 1997-2002, on average, 271 bicycle crashes are reported annually to the Metropolitan Police Department (MPD) in the District of Columbia, representing nearly 2 percent of crashes by all transportation modes. This report of bicycle collision data for the years 2000 through 2002 represents one effort to improve the safety of District cyclists. It uses and expands upon the methods developed in the past three District of Columbia bicycle and pedestrian collision studies (Angelis et al., 1979; DDOT, 1980; DDOT, 2002) which utilized police crash reports to summarize statistical data and locate areas of high risk for bicyclists and pedestrians. Analysis of police collision reports assists in understanding the underlying reasons of why collisions occur. Aggregating this data reveals trends that are useful in predicting future occurrences. Most often this information is used to identify high-risk areas for evaluation and modification, for improving educational and safety programs, and targeting these programs to vulnerable groups.

The District Department of Transportation (DDOT) is committed to improving the safety of all transport modes. DDOT has set strategic goals for increasing bicycle mode share and reducing crashes (DDOT, 2001a). Improving cyclist safety is an objective of DDOT's Comprehensive Safety Plan (DDOT, 2001b) and draft Bicycle Master Plan (Toole Design Group, 2004). The safety plan calls for producing an annual report on bicycle crash data, while the Bicycle Master Plan sets an ambitious goal of decreasing the rate of bicycle collisions with motor vehicles from 26 reported bike crashes per 1 million bike trips in 2000, to 20 per 1 million bike trips in 2010, and 15 per 1 million bike trips in 2020. District bicycle collision studies are an essential resource for identifying the sites of high concentrations of bicycle crashes that should be evaluated and improved (Toole Design Group, 2004).

This report begins with a summary of key findings from the 2000-2002 police crash data, and its implications for planning and policy. Next, information is presented on bicycle collision types, location (including GIS mapping), contributing circumstances, and profiles of the involved bicyclists and motorists. The time of the crashes is analyzed by hour, day, month, and season; and traffic conditions, traffic controls, road type, weather, and lighting are also examined. Following the summary of findings, the report compares significant similarities and differences between past bicycle collision studies and the 2000-2002 data. The report concludes with a discussion of data limitations and recommendations for next steps.

Data Sources and Methods

Typically, crash[1] analyses are compiled from crash reports completed by police; this report is no exception. The crash information is drawn from the District of Columbia's Traffic Accident Reporting and Analysis System (TARAS) data files. TARAS was developed in 1994 to help the DC Department of Public Works and various other agencies analyze traffic collisions in the District. The TARAS application is designed to accept certain information from the Police Department's PD-10 accident reporting form, and to manipulate the data for analytical and reporting purposes (Precision Systems Inc., 1994). Collision reports are collected and entered on an annual basis. Currently, the system contains reports from 1997 to 2002. All collisions involving injuries are included in the police reports; however, for those crashes with only property damage, the damage must be greater than $1,200 for a police report to be written.

Data for this report (period 2000-2002) was analyzed using both database and spreadsheet software (Microsoft Access and Excel). Queries were created to extract the relevant information from the database. Next, the data was exported to a spreadsheet for analysis and graphing. A Geographic Information System (GIS) was used to create maps of crash locations, and to layer additional information (street functional classifications, road ownership, political wards, and population density) over those locations.

Studies have demonstrated that official crash records significantly underestimate the number of bicycle-motor vehicle crashes. The reason is that injuries to bicyclists that do not involve a motor vehicle, occur off the public roadway, or result in relatively less serious injuries are not likely to be reported (FHWA, 2003). One study of hospital emergency room data found that only 48 percent of crashes involving cyclists were reported on official crash records (Stutts and Hunter, 1998); a 1998 survey with data on 1,956 members of the League of American Bicyclist members reported that only 28 percent of serious crashes were reported to the police (Moritz, 1998); and a 1976 study of 4,065 cyclists who rode a cumulative 10.4 million miles through 10 states across the U.S. on all types of roadways confirmed low reporting of bicycle crashes with as few as 10 percent of crashes reported to law enforcement officials and only 32 percent reported to medical or insurance officials (Burden and Burgess, 1978).

National level data also tends to underreport bicycle collisions. For the year 2002, the US Department of Transportation's National Highway Traffic Safety Administration reported 662 bicyclist fatalities and an additional 48,000 persons injured in traffic crashes, accounting for approximately 2 percent of all traffic fatalities and injuries (NHTSA, 2003). In contrast, the U.S. Consumer Product Safety Commission's National Electronic Injury Surveillance System (NEISS), which provides a national probability sample of hospital emergency room visits for

[1] Many studies have used the word accident when referring to a fall, collision, crash, or other event that causes property damage, injury, or death. However, this word describes an event during which something harmful or unlucky happens unexpectedly or by chance: it implies no fault. This is false since the vast majority of "accidents" are preventable and fault can be assigned (City of West Palm Beach, 1996). Therefore, this report will use the words crash or collision to refer to any event that causes property damage, injury, or death.

injuries associated with consumer products, estimates that there were 521,328 bicycle-related injuries in 2002, excluding mountain and all-terrain bikes (CPSC, 2004).

Comparison of District of Columbia bicycle crash reports between national, state, and local jurisdictions is problematic. National statistics are limited and usually are estimated from surveys and limited population groups (CPSC, 1994; Kaplan, 1975; Moritz, 1998). On the other hand, while many state departments of transportation produce reports on bicycle crashes, the geography of a state is too large of an area to compare with a dense urban city such as Washington, DC. Municipal level data is the best for comparison, but many issues can cloud the analysis. Municipal level studies are sporadic (in the same manner that studies in the District occurred in 1978 and 1979, and then had a gap until 1997) and difficult to find. In addition, bicycling conditions in other cities, including weather, streets, bicycle facilities, density, traffic volume, and bicycle mode share (to name a few), vary greatly by location. Nonetheless, the author includes one comparison to a report of metropolitan Boston bicycle-motor vehicle crashes (Plotkin and Komornick, 1984).

Summary of Findings

Key Findings

The bullets below present the key findings from the 2000-2002 study found in each of the sections outlined in this chapter.

- Injuries resulted from 82 percent of the bicycle collisions, while fatalities occurred in only .5 percent of incidents.
- 96 percent of bicycle collisions involved some type of motor vehicle.
- 68 percent of crashes occurred at an intersection; 31 percent occurred at non-intersection locations.
- Among the City's eight political wards, wards 1 and 2 had the highest percentage of bicycle crashes at 18.4 and 37.3 percent respectively.
- Cyclists were only slightly more likely than motorists to be at fault in a crash (31 percent versus 26 percent).
- The highest rate of contributing circumstances for cyclists involved in a collision was *auto right-of-way* (26 percent) followed by *driver inattention* (15 percent). For motorists, these were reversed—*driver inattention* (24 percent) and *pedestrian right-of-way* (17 percent).
- 85 percent of the cyclists involved in crashes were male.
- Cyclists between the ages of 25 and 34 had the highest involvement in bicycle collisions (26 percent) of any other age group.
- Motor vehicles from outside of DC were involved in 55 percent of bicycle collisions.
- Thursday had the highest frequency of bicycle collisions (19 percent), while Sunday at the lowest (8 percent).
- 42 percent of crashes occurred during the weekday morning and evening rush hours.

Key Implications

Since crash reports analyze past trends to indicate future events, these findings have significant implications for addressing data limitations found and taking next steps in planning and public policy. In the former, a number of data limitations were uncovered during the research. These include a need for additional exposure data (i.e., how many bicyclists and pedestrians are exposed to traffic and the risk of a crash) and improvements on the Police Department's PD-10 forms used to gather the data.

Twenty recommendations for next steps are detailed in the report and can be categorized into four areas:
(1) Improved information—including performing crash analysis on an annual basis and improving data sharing between the DC Metropolitan Police Department and other police departments in the District.
(2) GIS research and analysis—including, among others, using GIS to determine roadway functional classifications that have a statistically significant effect on the type and frequency of collisions and mapping bicycle facilities (e.g., bike lanes, signed bike routes) to determine if any of these have a statistically significant effect on the type and frequency of collisions.

(3) Enforcement and engineering—including enforcement targeted to peak hours and locations, and evaluating intersections with the highest frequencies of collisions for safety modifications.
(4) Training, education, and public involvement—including initiating a program of police training to increase awareness of the purpose of crash reports and proper coding, education geared toward drivers and cyclists, and promoting greater ANC involvement in bicycle crash safety awareness.

Bicycle Collision Numbers
Over the six-year period from 1997 to 2002, an average of 271 collisions involved bicycles every year in the District of Columbia. Overall, there were 92,824 reported traffic collisions for the six-year period; of those, 1.75 percent or 1,627 involved bicyclists (see Table 1). All of the data reported in this section of the report is based on the total number of collisions involving bicycles in the 2000-2002 period–or 853 incidents.

Bicycle collisions increased 10 percent for the period 2000–2002 over the period 1997–1999. However, one must take into account that total collisions (representing all transport modes) increased 43 percent during the same period. This rise in total collisions was most likely due to improved collection of information and coordination between MPD and DDOT, rather than any actual increase in collisions. Due to this increase in total collisions, the bicycle share of the percent of total collisions actually decreased from 2 percent (1997-1999) to 1.6 percent (2000-2002).

Of note is the fact that the number of bicycle collisions dropped precipitously from 2001 to 2002 (by 61 crashes or 20 percent). However, caution should be used in interpreting short-term trends as "collision exposure varies from year to year and is influenced by such factors as population growth, the number of bicyclists, the number and length of trips made, the development of bicycle facilities, roadway-safety improvements, and weather" (Wessels, 1996).

Table 1: Bicycle Collisions in the District of Columbia, 1997-2002

Year	Collisions Involving Bicycles	Total Collisions	Percent of Total
1997	259	13,896	1.86%
1998	253	11,341	2.23%
1999	262	12,955	2.02%
3-yr Total	774	38,192	2.03%
2000	314	18,589	1.69%
2001	300	18,309	1.64%
2002	239	17,734	1.35%
3-yr Total	853	54,632	1.56%
6-yr Total	1,627	92,824	1.75%

Bicycle Collision Type

As outlined above in Table 1, for the three-year period, 2000 through 2002, there were 54,632 reported traffic collisions; of the 853 bicycle collisions, 695 (or 81.5 percent) resulted in injuries, 154 (18 percent) caused property damage, and only 4 (or 0.5 percent) resulted in fatalities (Figure 1). In addition, 111 of the 853 total collisions were "hit-and-run" meaning that one or more of the involved parties fled the scene.[2] In hit-and-run crashes, only partial data (or none at all) is available, resulting in fragmented information from those crashes for this analysis.

Figure 1: Bicycle Crash Results 2000-2002

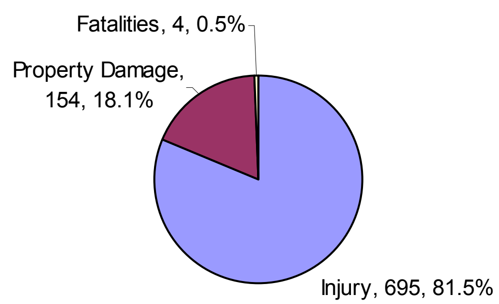
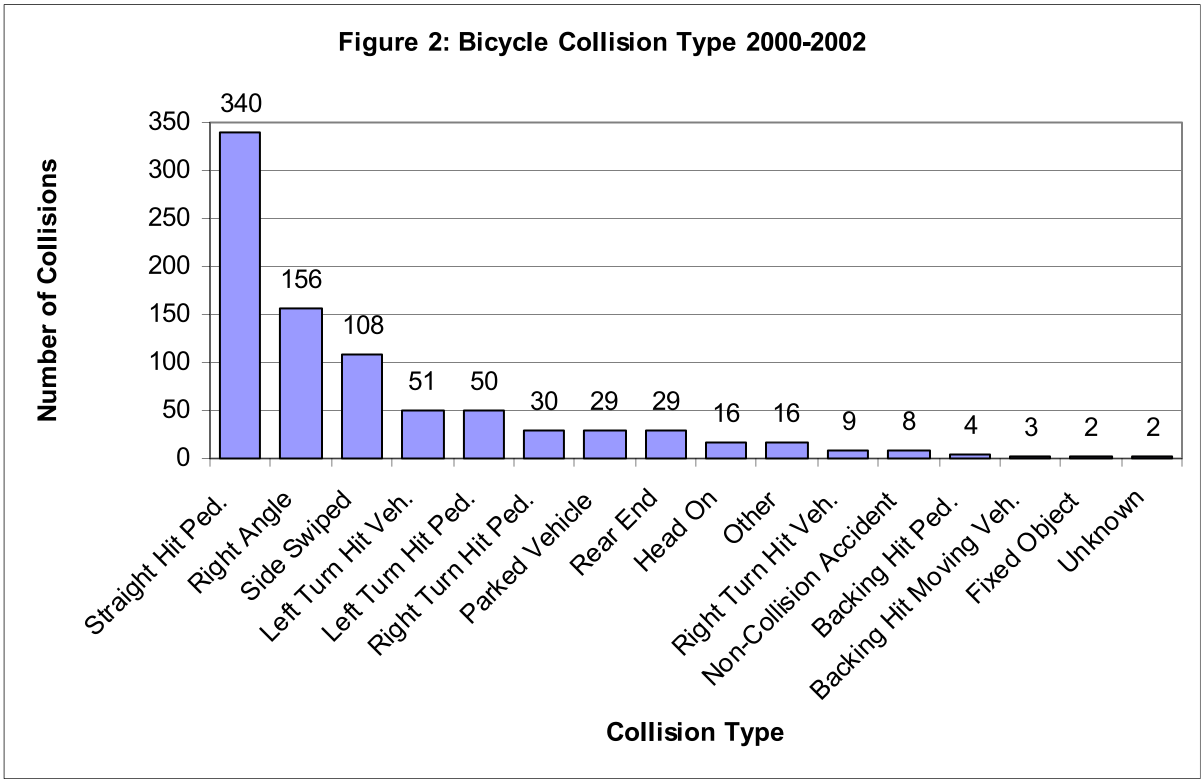


Figure 2 reports on bicycle collision types in D.C. from 2000-2002. Over one-third of collisions (40 percent or 340 incidents) were reported as a "straight hit pedestrian." In this case, pedestrian refers to the bicyclist and the collision occurred straight-on rather than at an angle. Another fifth (18 percent or 156 incidents) were categorized as a "right angle," meaning that the bicycle and other vehicle collide at a right angle, most likely at an intersection or driveway where paths would cross. Thirteen percent (or 108 incidents) were a "side swiped," indicating that a vehicle traveling in the same direction turned into the path of the bicyclist. Less likely, but still above 3 percent of collisions were "left turn hit vehicle" (6 percent or 51 incidents), "left turn hit pedestrian" (6 percent or 50 incidents), "right turn hit pedestrian" (3.5 percent or 30 incidents), and "rear end" and "parked vehicle" (3.4 percent or 29 incidents each). Eight other categories made up less than 2 percent of incidents each.

[2] In bicycle-motor vehicle collisions, in this report, the motorist is the most likely to leave the scene of the crash. This is due to the fact that a collision must either cause injury or at least $1,200 in property damages in order for the police to write a crash report.



Note: Pedestrian in this case refers to the bicyclist.

Bicycle Collision Roadway Locations

The MPD PD-10 report differentiates between "on-street" and "off-street" collisions; however, these sections are often left blank or are inaccurate. Of the 853 total bicycle collisions, 840 (98 percent) took place on streets: 419 collisions (49 percent) occurred at an intersection; 265 (31 percent) were within 100' of an intersection; 155 (18 percent) were not at an intersection; 11 (approximately 1 percent) crashes were left blank; and 3 (less than 1 percent) were identified as not applicable (see Figure 3).

Determining whether a crash occurred at an intersection or mid-block is an important element in preparing appropriate countermeasures (Dhillon et al., 2001; Wachtel and Lewiston, 1994). Currently, the PD-10 form provides no such classification. In Long Beach, California, police reports define and classify a mid-block collision "as a collision that occurred greater than 25 feet from the intersection" (Dhillon et al., 2001). Using this definition on the 2000-2002 data, 263 (31 percent) of the 853 total bicycle collisions occurred at a mid-block location; 67.5 percent occurred at an intersection.

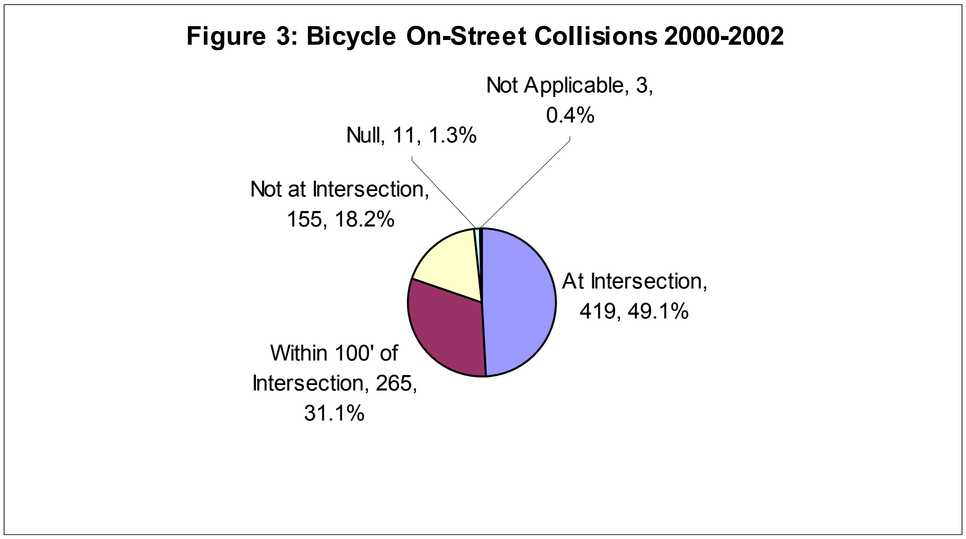
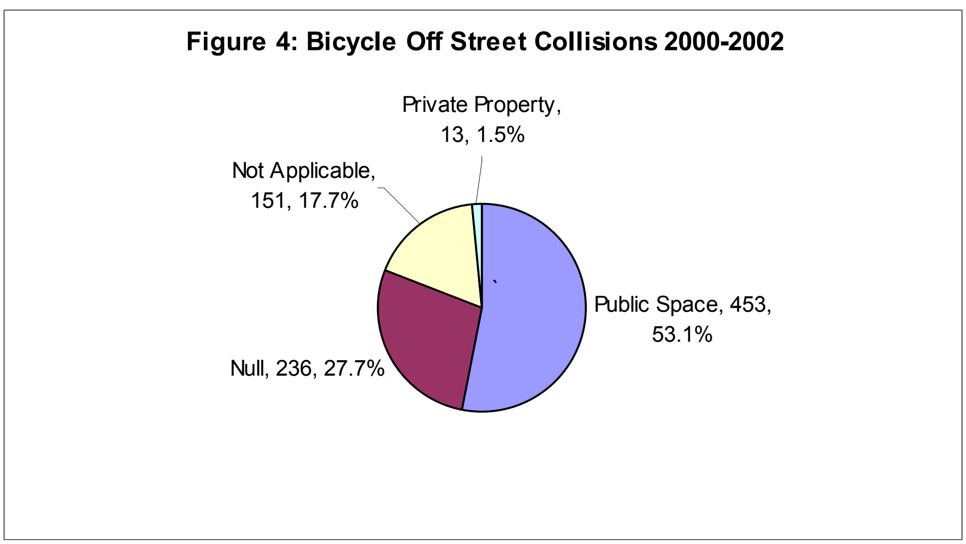


Figure 4 displays the division of "off-street" collisions. Of the total 853 bicycle collisions, 453 crashes (or 53 percent) took place on public space; 236 crashes (or almost 28 percent) were left blank; 151 (almost 18 percent) were listed as not applicable; and 13 crashes (1.5 percent) were listed as occurring on private property. However, due to the fact that the majority of collisions occurred at on-street locations (as reported above, only 14 crashes could be defined as off-street) and the 453 marked as public space in the off-street location field, the accuracy of officers' reports on this field on the PD-10 form needs to be called into question. The only statistic that correlates well are the 13 marked as private land in the off-street category (this matches the total 14 collisions reported null or not applicable).



Crash Location Maps and Breakdown of Crashes by City Wards

Bicycle crash locations for 2000-2002 were mapped with the GIS software program, ArcView, using either the intersection name or block address, if provided.[3] Of the 853 total bicycle collisions for the three-year period, only 793 contained enough information to reasonably depict the collision location. Sixty-two incidents had block information that differed from the intersection (e.g. 1519 9th St NW versus 1500 9th St NW or 15th and P St NW).[4]

Map 1 (see Appendix) displays the 646 unique crash locations for the years 2000 to 2002 by road ownership. According to the Federal Highway Administration (FHWA), DDOT owns 1,427 of the 1,535 total miles of roads in the District of Columbia. Other federal agencies own 89 miles of roads and 22.7 percent of land area within the District.[5] Agencies such as the National Park Service, the Architect of the Capitol, and the military police a majority of these roads and, since there is no formal means of sharing crash data between these agencies and DDOT, the data was not readily available for this report.

Map 2 shows the same 793 crashes in the 646 separate locations, but overlays the road functional classifications as well.[6] A quick study of this map shows that most crashes occur on arterial and collector roads (which together only account for 27 percent of total road miles). Gathering bicycle exposure data (i.e. how many bicyclists use certain roads) would yield valuable insights into whether cyclists are at a greater exposure to risk on these roads or, alternatively, if more bicyclists are using these roads than the local residential streets.

Map 3 displays the bicycle crashes per political ward[7] and Table 2 provides the details of the map. Over a third (37 percent) of bicycle collisions in 2000-2002 took place in Ward 2; and close to a fifth (18 percent) in Ward 1. Ward 6 followed with 14 percent; and all other wards of the city fell below 10 percent.

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[3] The GIS data analysis completed by the author for this paper has recently been included in the Draft Bicycle Master Plan (Toole Design Group, 2004). See Map 7: Reported Bicycle Crashes (2000-2002).

[4] Intersection and block number address data simplify GIS mapping procedures. With this information, crash locations can be mapped automatically. The remaining 202 crash locations that did not occur at an intersection could be mapped individually using the "feet from object" (meaning cross-street) specified in the PD-10 report. However, this is a cumbersome and time-consuming process which can yield questionable results due to the estimated nature of this data.

[5] Another 19 miles of District roads include State park, State toll, other State agency, other local agency and other roadways not identified by ownership.

[6] Of the 1,535 miles of roads within the District of Columbia, 13 miles are classified as interstate, 22 miles as other freeways and expressways, 91 miles as principal arterial, 173 miles as minor arterial, 152 miles as collector, and 1,084 miles (or 70.6 percent) as local.

[7] The District of Columbia is divided geographically into eight political wards and further sub-divided into Advisory Neighborhood Commissions (ANCs). For the 80 crashes that occurred on the boundaries of political wards, the author equally divided the numbers between the adjacent wards.

Table 2: Bicycle Collisions in City Wards 2000-2002		
Ward	**Number of Collisions Involving Bicycles**	**Percent of Total Collisions (n=793)**
1	146	18.4%
2	296	37.3%
3	43	5.4%
4	50	6.3%
5	62	7.8%
6	114	14.4%
7	49	6.2%
8	33	4.2%
Total	**793**	**100.0%**

Table 3 lists all intersections with 4 or more crashes for 2000-2002 by political wards.[8] Seventeen of the 19 intersections with 4 or more crashes are located in ward 2 (13 intersections) and ward 1 (4 intersections). One intersection with 4 or more crashes was located along the border of wards 1 and 2, and the final intersection was located in ward 3. These results should not be surprising. Ward 1 has the densest residential population, while ward 2 encompasses much of the central business district area containing the majority of the approximately 500,000 downtown city jobs (MWCOG, 2002). Both wards have many arterial and collector roads carrying high traffic volumes in a dense urban setting (see maps 2 and 4 in Appendix).

Table 3: Intersections with Four or More Crashes, 2000-2002		
Intersection	**Number of Crashes**	**Ward**
17TH St, Connecticut Ave & K St NW	8	2
14TH St & L St NW	6	2
14TH St & Columbia RD NW	5	1
16TH St & L St NW	5	2
20TH St & Massachusetts Ave NW	5	2
20TH St & Pennsylvania Ave NW	5	2
13TH St & G St NW	4	2
13TH St & I St NW	4	2
17TH St & I St NW	4	2
18TH St & California St NW	4	1
18TH St & Columbia Rd NW	4	1
19TH St & M St NW	4	2
Georgia Ave & Newton Pl NW	4	1
19TH & L St NW	4	2
22nd St & M St NW	4	2
29TH St & M St NW	4	2
15TH St & Pennsylvania Ave NW	4	2
Connecticut Ave & T St NW	4	1/2
Wisconsin Ave & Calvert St NW	4	3

[8] Based on this analysis, seventeen of the 19 intersections have been included in the Draft Bicycle Master Plan as recommended locations for evaluation and possible safety enhancements (Toole Design Group, 2004, p. 27).

Map 4 overlays the crash locations with the political wards and the year 2000 population density of each of the city's 188 census tracts. In 2000, the District of Columbia had 572,059 residents living within 61.4 square miles of land area (U.S. Census Bureau, 2000). The population density in each census tract ranges from 0 persons per square mile of land area to 57,507 persons per square mile of land area; the city average is 9,316 persons per square mile of land area. It is interesting to note that the bicycle crashes tend to cluster in the denser tracts. One exception is in ward 2 which contains most of the District's 500,000 downtown jobs (MWCOG, 2002). In this case it is likely that cyclists are involved in crashes while commuting to or from their places of employment on crowded downtown streets, although destination surveys and exposure data would be necessary to support this hypothesis.

Vehicles Involved in Bicycle Collisions

Tabulating the four "vehicle type" columns for the years 2000-2002 finds that 1,725 vehicle types (including bicycles and pedestrians) were involved in the 853 bicycle collisions. Table 4 gives the breakdown of the number of each type of vehicle involved in the crashes. Close to 50 percent (or 855) of the vehicles involved were bicycles, while another 815 (or 47 percent) were some type of motor vehicle (e.g., passenger auto, taxi cab, bus). Only 31 pedestrians (or close to 2 percent) were involved.

Table 4: Vehicles Involved in Bicycle Collisions, 2000-2002

Vehicle Type	Number	Percent of Total Vehicles (n=1725)
Bicycle	855	49.6%
Passenger Auto	678	39.3%
Taxi Cab	74	4.3%
Truck/Trailer	37	2.1%
Pedestrian-On Foot	31	1.8%
Bus	23	1.3%
Police	10	0.6%
Other	8	0.5%
Unknown	6	0.3%
Motorcycle	3	0.2%
Total	**1725**	**100.0%**

Table 5 is a summary of all vehicle combinations involved in the 853 bicycle collisions and their frequencies in collisions with cyclists. The vast majority (76 percent) were a combination of passenger auto and bicycle. However, if you add up all combinations involving motor vehicles of some sort (e.g., passenger auto, taxi, etc.,) and bicycles, these make up 96 percent (or 822) of the combinations. Bicycle/pedestrian crashes only make up 3.4 percent (or 29 incidents), while bicycle/bicycle combinations account for only .2 percent of all collision combinations reported.

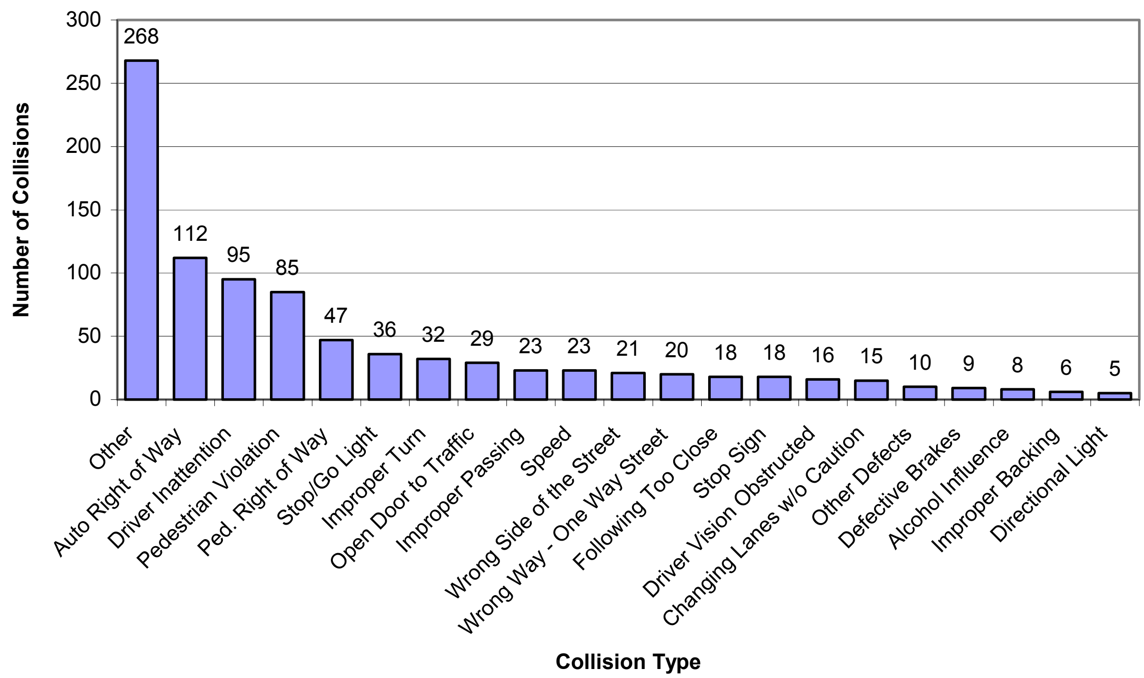
Table 5: Vehicle Combinations Involved in Bicycle Collisions 2000-2002					
Vehicle 1	**Vehicle 2**	**Vehicle 3**	**Vehicle 4**	**Number**	**Percent (n=853)**
Bicycle	Passenger Auto			648	76.0%
Bicycle	Taxi Cab			71	8.3%
Bicycle	Truck/Trailer			37	4.3%
Bicycle	Pedestrian-On Foot			29	3.4%
Bicycle	Bus			21	2.5%
Bicycle	Passenger Auto	Passenger Auto		9	1.1%
Bicycle	Police Scout Car			7	0.8%
Bicycle	Bicycle	Passenger Auto		5	0.6%
Bicycle	Other			4	0.5%
Passenger Auto	Other			4	0.5%
Motorcycle	Bicycle			3	0.4%
Bicycle	Unknown			2	0.2%
Bicycle	Bicycle			2	0.2%
Passenger Auto	Bicycle	Taxi Cab		2	0.2%
Bicycle	Bicycle	Taxi Cab		1	0.1%
Bicycle	Bus	Pedestrian-On Foot		1	0.1%
Bicycle	Passenger Auto	Bus		1	0.1%
Bicycle	Police -Other			1	0.1%
Bicycle	Police Scout Car	Passenger Auto		1	0.1%
Bus	Bicycle	Bicycle		1	0.1%
Passenger Auto	Passenger Auto	Passenger Auto	Bicycle	1	0.1%
Police Cruiser - Unmarked	Bicycle			1	0.1%
Truck/Trailer	Bicycle	Passenger Auto		1	0.1%
			Total	**853**	**100.0%**

Contributing Circumstances of Bicycle Collisions

Figure 5 contains categories of circumstances that were indicated as contributing to the crashes[9] for all involved vehicles (e.g., passenger auto, bicycles, truck/trailer). The single largest category is “other,” (268 incidents or 30 percent) which is not defined. The 111 hit and run collisions may explain some of this category, however, it still leaves over 150 unexplained contributions to the crashes. This large amount of missing data complicates the determination of what party was at fault, discussed next in this report. Approximately 12 percent of contributing circumstances were “auto right of way,” 11 percent were driver inattention and 9 percent were pedestrian (including bicyclist) violations. Seventeen other types of contributing circumstances made up less than 5 percent of all circumstances each, but each had over 5 occurrences.

[9] The 765 “no violations” were eliminated, leaving 900 contributing circumstances that had a possible impact on the collision; those categories with less than 5 occurrences were not included in the chart: right turn on red (when prohibited)-2; disobey yield sign-1; and improper starting-1.

Figure 5: Contributing Circumstances in Bicycle Collsions 2000-2002



Crash Causation and Driver Profiles

The researchers of the 1979 study (Angelis et al., 1979) analyzed all of the police crash reports involving bicycles. From this, they were able to determine causation and group each crash into ten of the bicycle crash categories developed by Cross and Fisher (1977). Angelis and colleagues also added three other categories to the Cross and Fisher ones to more accurately capture the majority of the collisions.

Unfortunately, crash typing using the categories from 1979 study is not possible using the TARAS system since the officers' crash descriptions and diagrams are not included. However, fault, or causation, can be estimated by evaluating the contributing circumstances for each collision. Using causation analysis on the 2000-2002 data, cyclists had a slightly higher percentage of fault: 31 percent for cyclists (out of 855 contributing circumstances) versus 26 percent for motorists (out of 833 contributing circumstances).

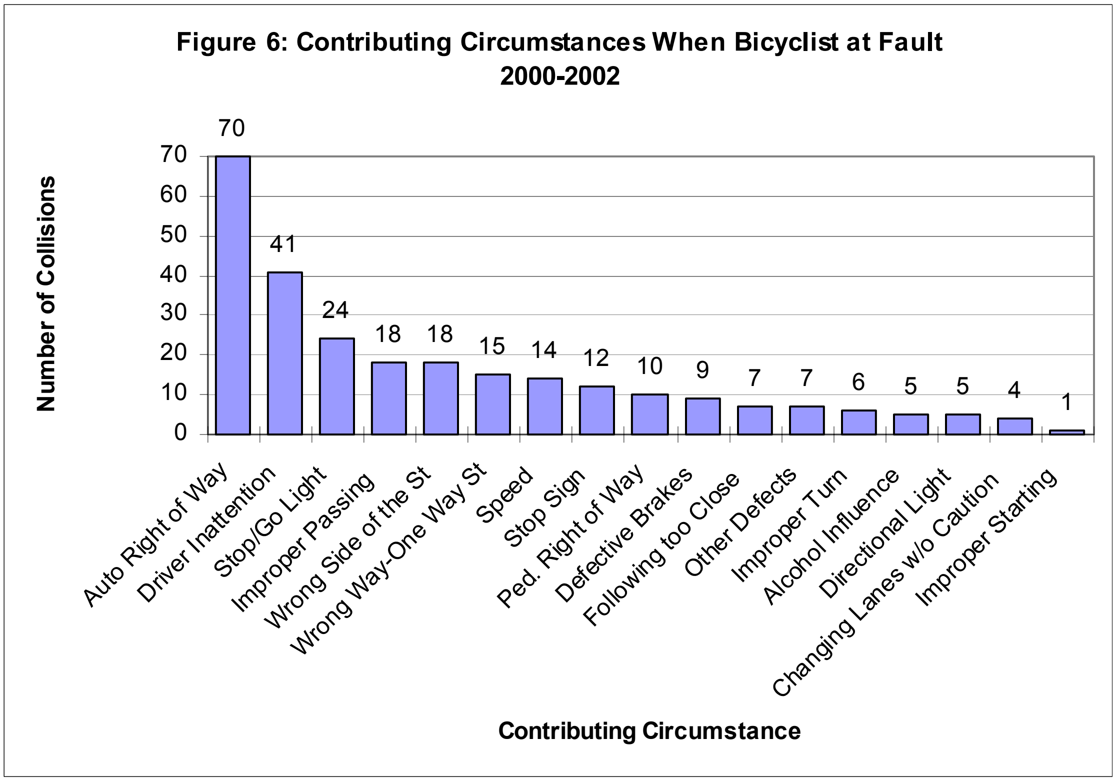
Of all drivers (motorists and bicyclist), drinking was a known factor in only 12 of the collisions. Of these, 7 bicyclists and 5 motorists were known to be drinking. Fatigue contributed to 9 of the collisions: cyclists were fatigued 5 times and "apparently asleep" in another 4 crashes, while motorists were "apparently asleep" in 3 of the collisions.

Bicycle Cause and Profiles

Figure 6 separates out the bicyclist contributing circumstances (that first appeared in Figure 5) into those occurrences that were found when the bicyclist was at fault. As noted above, out of

855 cyclist contributing circumstances, fault was found in 266 occurrences (31 percent). Approximately a quarter (26 percent) of all contributing circumstances were determined to be "auto right of way." Driver inattention was marked in about 15 percent of incidents, while a stop/go light was marked in about 9 percent of incidents. Fourteen other contributing circumstances were each marked less than 10 percent of time.

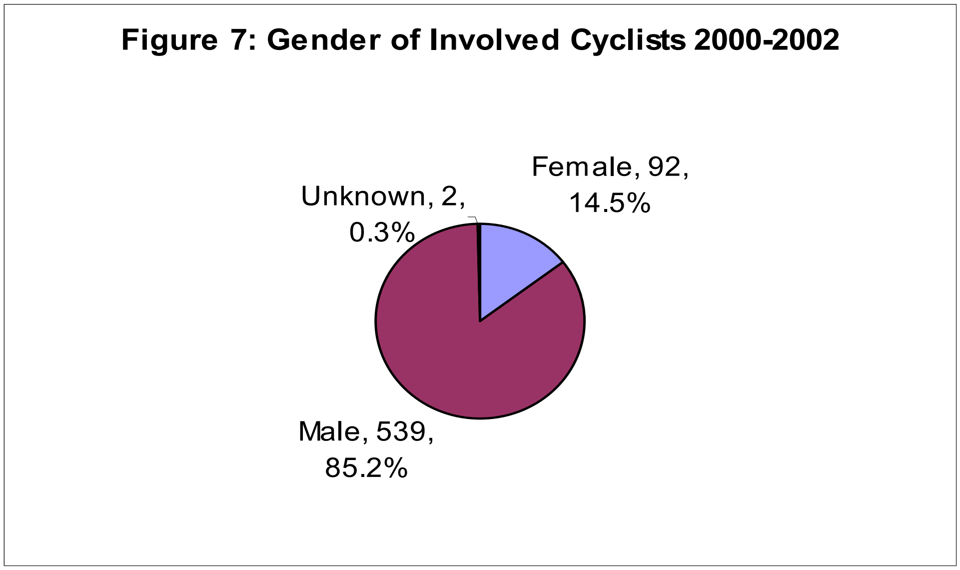
In addition, the cyclist was not at fault in 405 (47.5 percent) of the remaining 589 contributing circumstances: 336 were no violation, and 69 were pedestrian violations.[10] Fault could not be determined in 184 (21 percent) of the contributing circumstances: 150 were other, 28 were unknown, and driver vision was obstructed in 6 collisions.

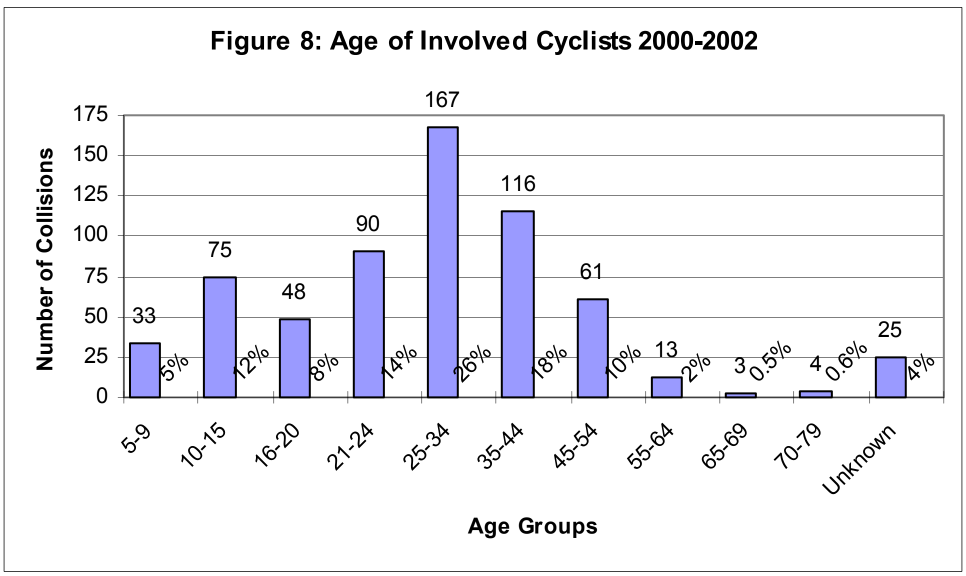


Out of 855 cyclists involved in collisions, gender information was available for 635. Of these, 85 percent were male, 14.5 percent female, and 0.3 percent were unknown (Figure 7). Accurate age information was available for 610. Of these, the average age was 29. Close to two-thirds (60 percent) of all bicyclists were between the ages of 21 and 44, and 83 percent were between the ages of 5 and 44 (Figure 8).[11] While these figures portray the age and gender of those cyclists involved in crashes, no conclusion can be made that males or cyclists *x to x* years of age are at a greater risk. That is, until the bicyclist population is accurately defined, the actual risks cannot be determined.[12]

[10] It is unclear if pedestrian violation refers to bicyclists or persons traveling on foot. If, however, pedestrian violation were to include bicyclists then the cyclist fault would increase to 39 percent.
[11] This data correlates well with a national study that found in 2002 the average age of those injured was 26.7 years, 75 percent were male, and 82 percent were between the ages of 5 and 44 (NHTSA, 2003).

[12] The author has been counting bicyclists at approximately 30 separate locations throughout the city, collecting information on the number of cyclists, their gender, helmet usage, and whether they ride on-street or the sidewalk.

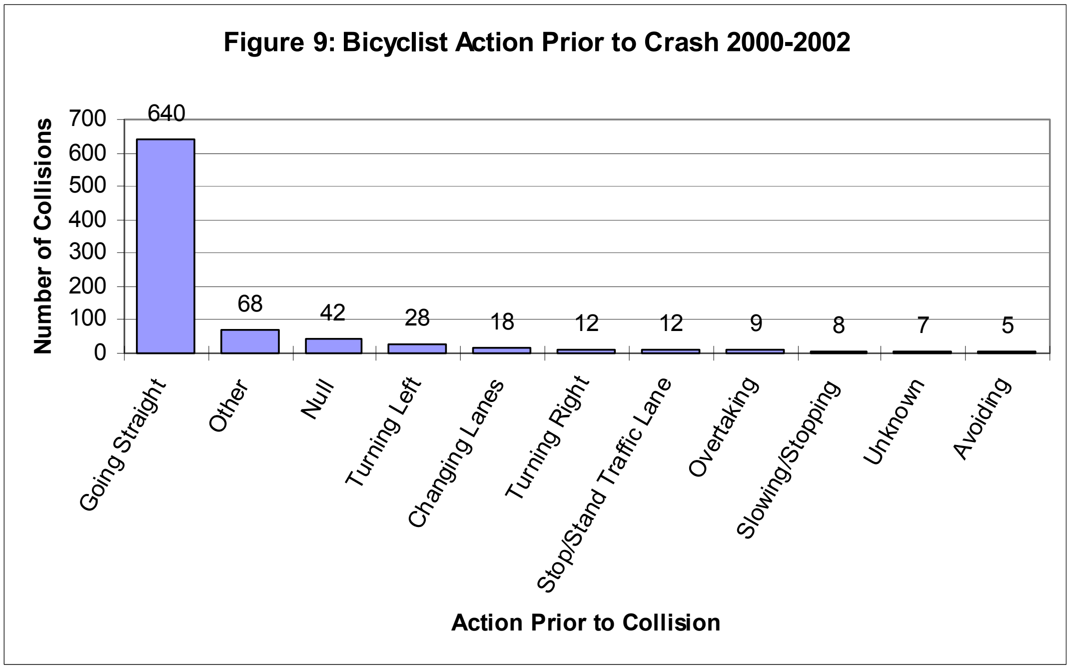




Data was available for the action of the bicyclist for the period immediately preceding the collision (Figure 9). The vast majority of cyclists (n=855) were going straight in nearly 75 percent (or 640) of the collisions.[13]

From 10 separate counts taken over 11 hours, 272 cyclists were observed, of which 217 (or 80 percent) were male and 55 (or 20 percent) were female. While this sample size is small, it does indicate that males are probably only slightly overrepresented in the crash reports.

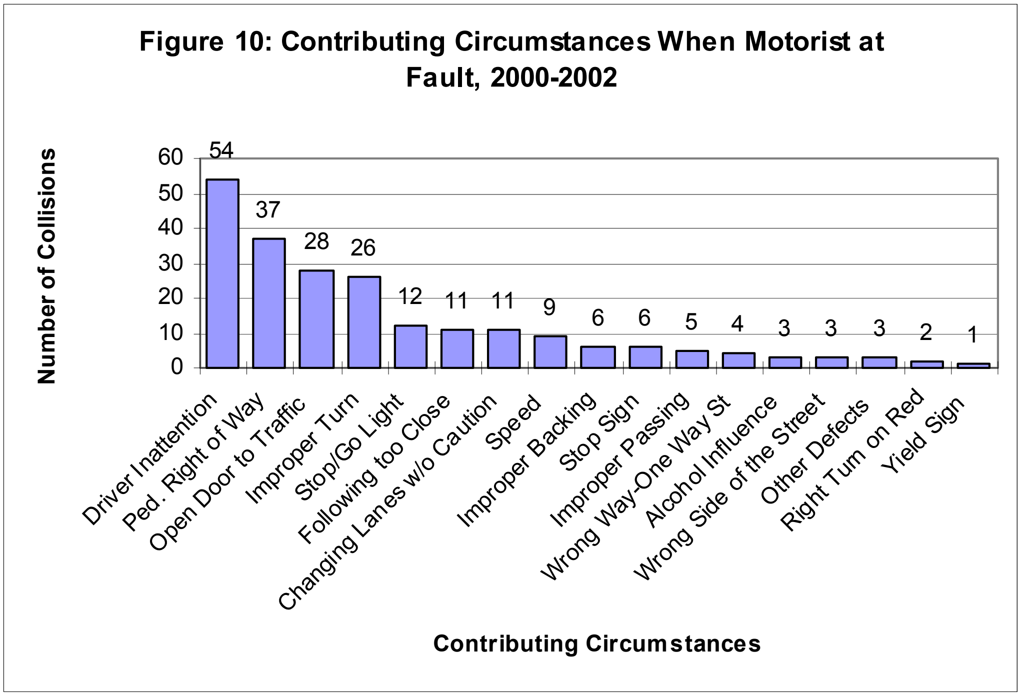
[13] Four other bicyclist actions that occurred in 0.2% or less of crashes were parked (2), entering/leaving parked position (2), ran off road (1), and merging (1).



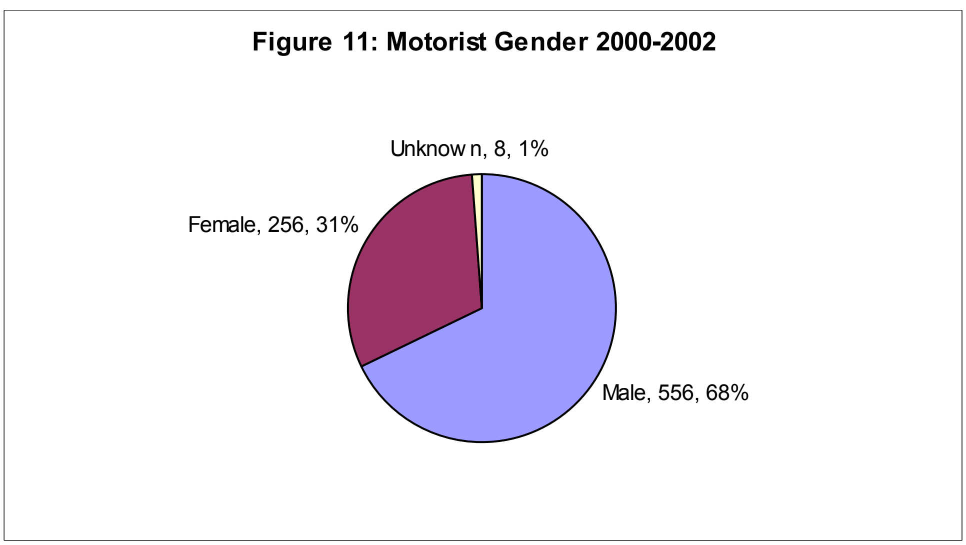
Motorists Cause and Profiles

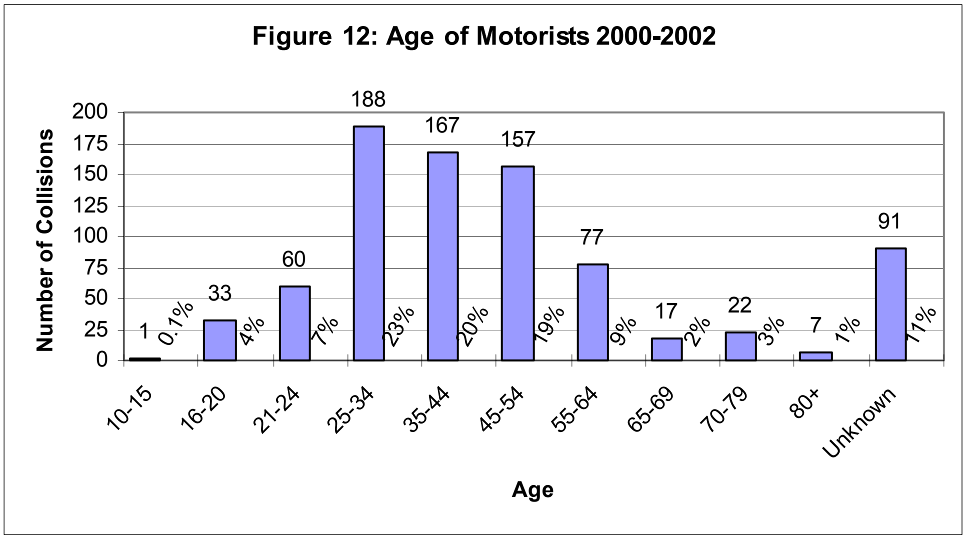
For motorists, there were a total of 833 contributing circumstances (first presented as part of the total contributing circumstances in figure 5); 221 (26.5 percent) in which the motorist was at fault. Almost a quarter (24 percent) were due to driver inattention (Figure 10), while 17 percent were due to not yielding to a pedestrian right of way, 13 percent from opening a door to traffic and 12 percent to an improper turn. Thirteen other contributing circumstances each accounted for 5 percent or less when motorists were at fault.

The motorist was not at fault in 457 (55 percent) of the remaining 612 contributing circumstances: 412 were no violation, 42 were auto right of way, and 3 were pedestrian violations. Fault could not be determined in 155 (19 percent) of the contributing circumstances: 115 were other, 30 were unknown, and driver vision was obstructed in 10.

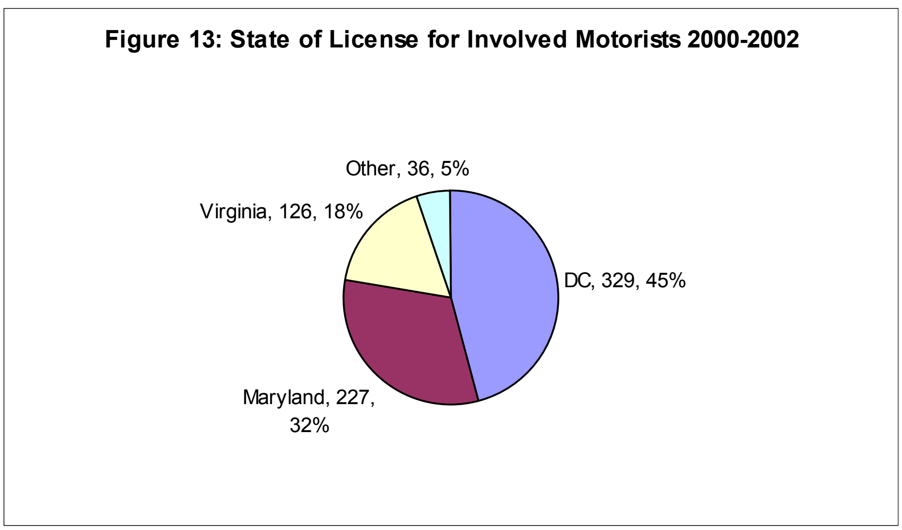


Out of 820 available records containing gender information on motorists, 556 (68 percent) were male, 256 (31 percent) female, and 8 (1 percent) were null or entered incorrectly (Figure 11). Accurate age information was available for 720 motorists (Figure 12). Of these, the average age was 41. Close to two-thirds (62 percent) can be found in the 25-54 categories. The high number of motorists with unknown ages (91) correlates with the number of hit and run accidents (111) for which little information would be available.

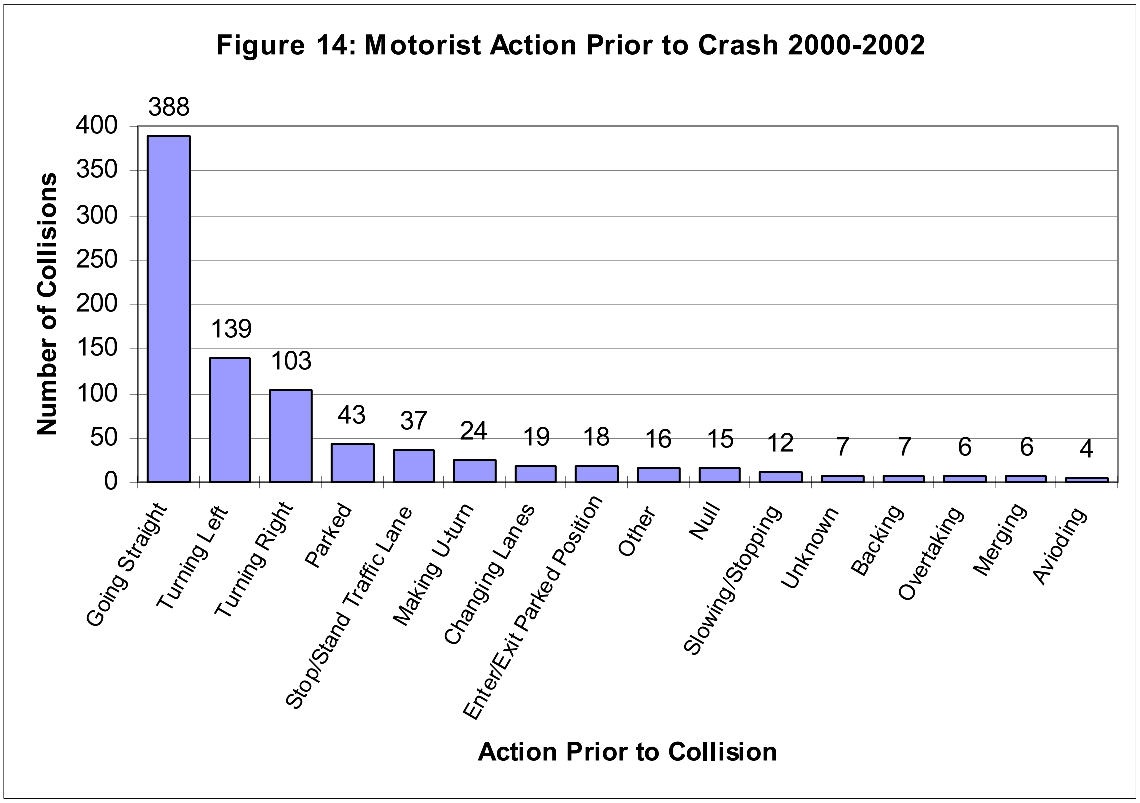




License plate tag information was available for 718 of the motorists involved (Figure 13). Of these, 329 (or 45 percent) had District of Columbia plates; 227 (or 32 percent) had Maryland plates; 126 (or 18 percent) had Virginia plates; and 36 (or 5 percent) had other or out of state plates. Interestingly, this means that automobiles (and presumably drivers) from outside the District are involved in a majority (55 percent) of bicycle collisions.

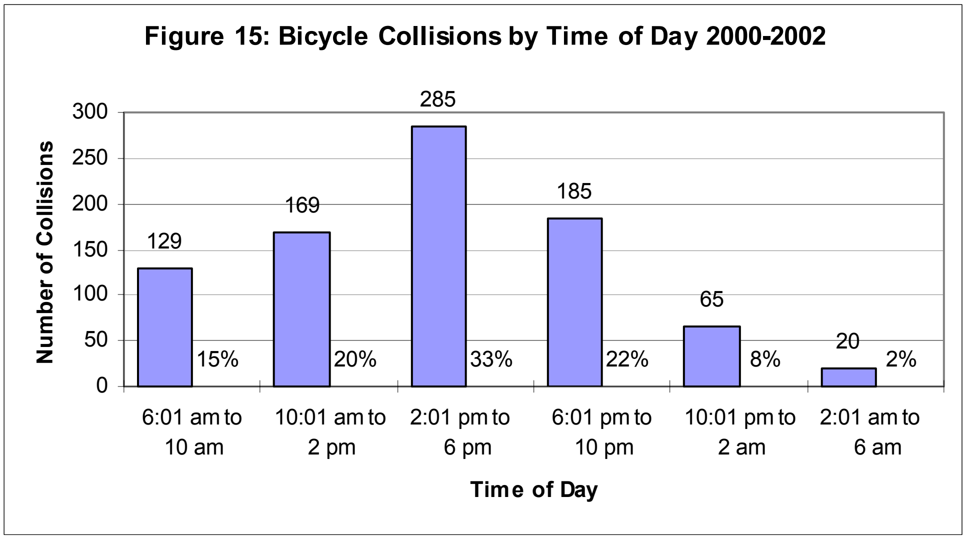


As can be seen in Figure 14, motorists (n=844) were going straight in only 46 percent (or 388 of the collisions) prior to the collision. This is in contrast to the 75 percent of bicyclists going straight at the time of the collision. Another 29 percent were turning either left or right, while another 5 percent were parked and 4 percent were standing in a traffic lane.

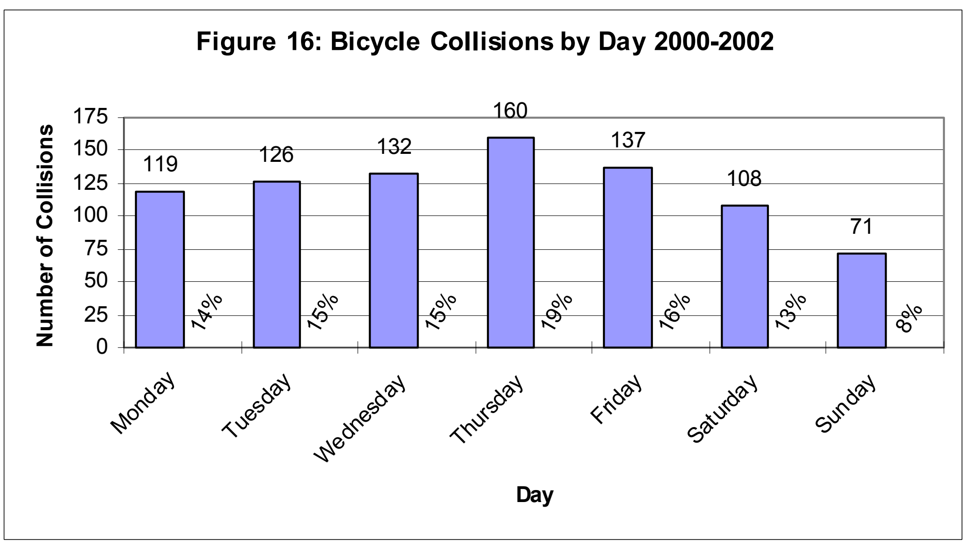


Time of Bicycle Collisions

The time data of bicycle collisions was analyzed by hour, day, month, and season. Not surprisingly, results varied depending on the data grouping. The hourly groupings used in Figure 15 are categories widely used in national reports such as the National Highway Traffic Safety Administration's *Traffic Safety Facts* (2003). As expected, a large number of crashes occur during rush and evening hours. For the years 2000 to 2002, almost half (48 percent) of all crashes took place during the periods of 6:01 am to 10 am and 2:01 pm to 6 pm. About a fifth each happened in the daylight hours and the later rush hour period—20 percent from 10:01 am to 2 pm and 22 percent from 6:01 pm to 10 pm. Only 10 percent occurred overnight between 10:01 pm and 6 am.



Separating the crashes into weekdays and weekends is important as well. Figure 16 breaks down the number of bike collisions that occurred on each day of the week. If crashes were to take place in equal numbers per day, each day would account for 14.3 percent of crashes and weekdays would constitute 71.4 percent of all crashes. As the figure indicates, while most crashes did occur between Monday and Friday (79 percent), there was some variation per day. Thursday had the highest frequency of bicycle collisions at 160 or 19 percent, while Monday had the lowest frequency (119 incidents or 14 percent)—a 5 percent difference. Only 21 percent, or 179 incidents, took place on Saturdays or Sundays.



Cross referencing day and time data helps further analyze these categories. The five daily weekday rush hours accounted for 42 percent of all weekday collisions: 15 percent of crashes occurred during the morning rush hours of 6:30 to 9:30 am, while 27 percent of crashes took place during the evening rush hours of 3:30 to 6:30 pm. In comparison, only 4 (2 percent) weekend crashes took place during the hours of 6:30 to 9:30 am, and 43 (or 24 percent) occurred between the hours of 3:30 to 6:30 pm.

Figures 17 and 18 demonstrate that the frequency of bicycle collisions have a distinctive seasonal pattern. As can be seen from the figures, most crashes happen in the summer months of June, July, and August (306 incidents or 36 percent). The spring months of March, April and May and the fall months of September, October, and November accounted for equal percentages of 26 percents each (or 224 and 220 incidents, respectively). Only 103 incidents, or 12 percent, of crashes took place during the winter months of December, January, and February. Due to favorable weather, the higher occurrences of collisions during the summer, spring, and fall seasons are most likely due to the presence of a greater number of cyclists during these months.

Figure 17: Bicycle Collisions by Month 2000-2002

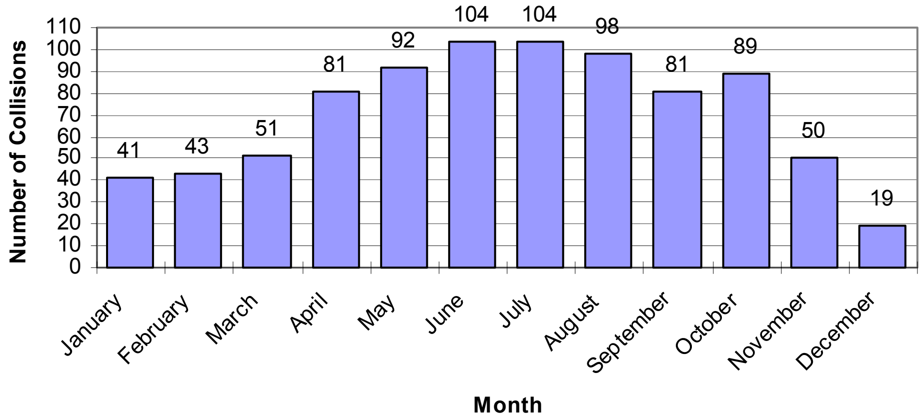
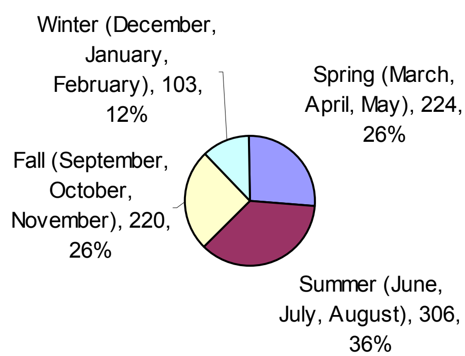


Figure 18: Bicycle Collisions by Season 2000-2002

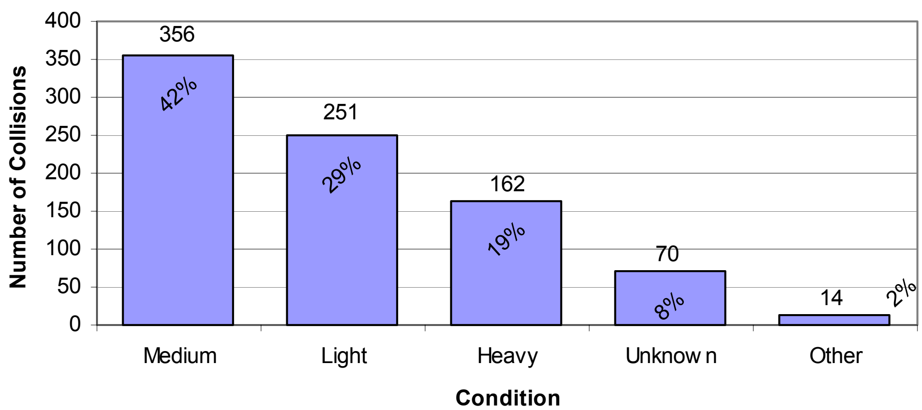


Road and Weather Conditions of Bicycle Collisions

Traffic Conditions and Road Types

Figures 19-21 depict the traffic conditions of the bicycle collisions, estimated by the responding officers. Almost half (42 percent) of the collisions occurred under medium traffic conditions. Almost a third (29 percent) under light traffic conditions, and a fifth (or 19 percent) under heavy traffic conditions (Figure 19). The fact that a majority (61 percent) of the crashes occurred in areas of medium to heavy traffic coincides with their location on arterial and collector streets (see map 2), which usually carry heavier volumes of traffic.

Figure 19: Traffic Conditions of Bicycle Collisions 2000-2002



A signal was present in 43 percent of incidents, while no traffic controls were present in 40 percent of the incidents. Only 10 percent of the incidents included a stop sign (Figure 20). In terms of road type, Figure 21 shows that the vast majority of all collisions (85 percent) occurred on a straight segment of road. Another 10 percent took place on a graded segment (5 percent) or a level segment (5 percent) of road. Four other road types made up less than 5 percent of incidents.

Figure 20: Traffic Controls of Bicycle Collisions 2000-2002

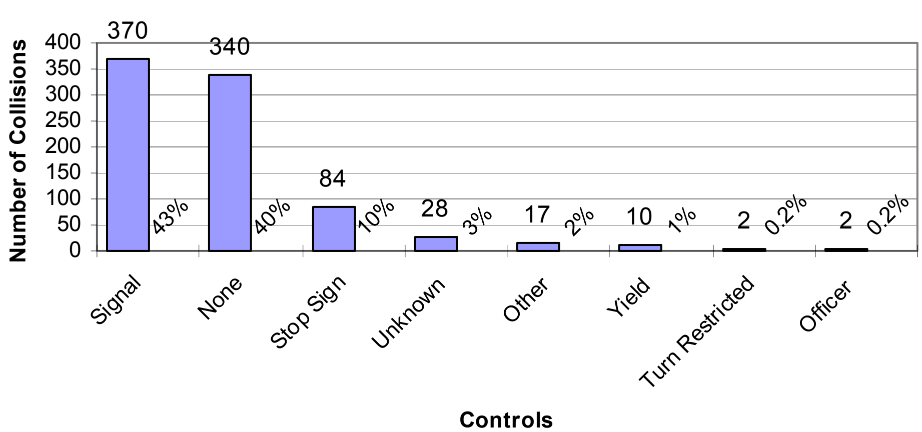
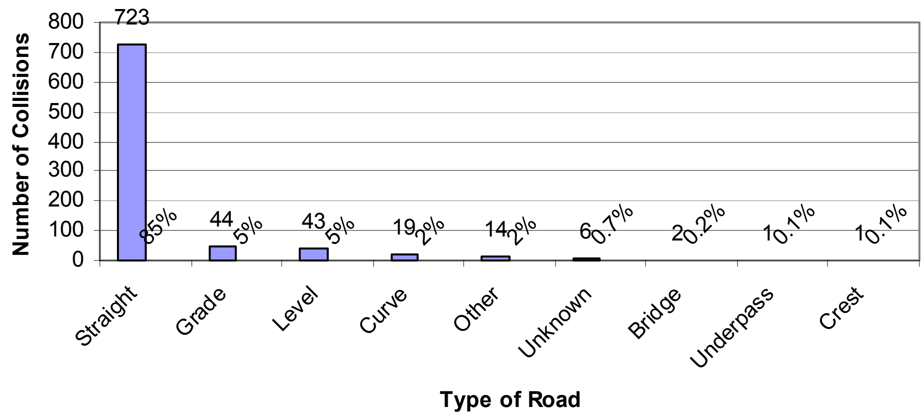


Figure 21: Road Type of Bicycle Collisions 2000-2002



Weather Conditions

As Figure 22 indicates, the vast majority of crashes (nearly 90 percent) occurred during clear conditions, while only 5 percent of crashes took place during rain. These percentages are consistent with the Plotkin and Komornick (1984) study. Figure 23 further indicates (and reinforces the data regarding weather conditions) that over 90 percent of crashes took place on dry roads, while wet road conditions were present in only 6 percent of crashes. Again, this is probably exposure-related. These percentages are again consistent with the Plotkin and Komornick (1984) study.

Figure 22: Weather Conditions of Bicycle Collisions 2000-2002

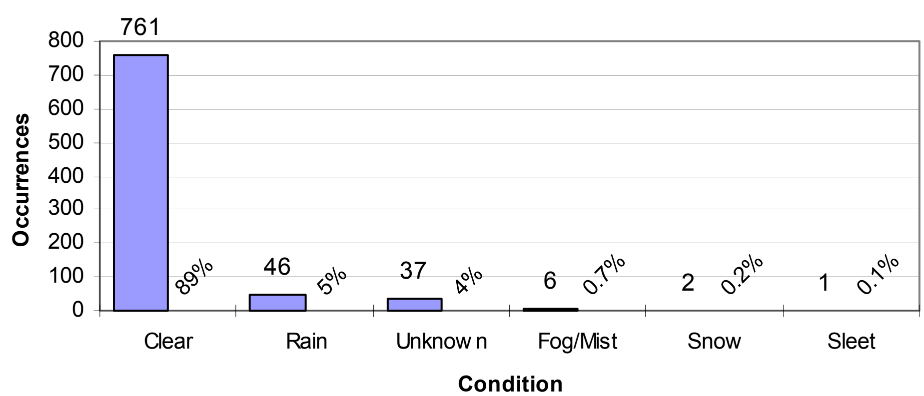
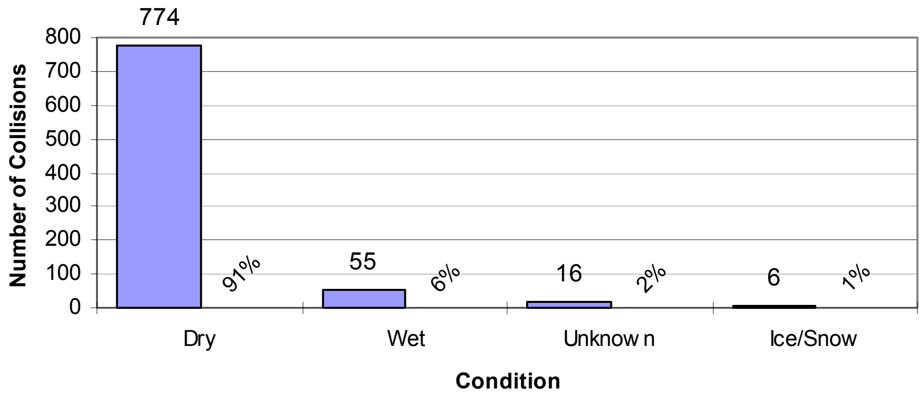


Figure 23: Road Condition of Bicycle Collisions 2000-2002



Lighting Conditions of Road

The data indicates that street lights were off in 68 percent of the bicycle collisions (584 collisions), while street lights were on in 23 percent of the collisions (or 196 incidents). Another 8 percent were unknown, non-response, or defective. Because street lighting conditions are affected by the light conditions of the day, the data was further analyzed by cross referencing it with light conditions. Figure 24 indicates that for those bicycle collisions occurring while street lights were off, 93 percent took place during the day, 3 percent during dawn or dusk and only 2 percent during the dark. The latter possibly points to defective lighting conditions during those incidents. Figure 25 indicates while street lights were on, 82 percent of the incidents took place during the dark, while 11 percent took place at dawn or dusk. Only 6 percent took place during daylight hours.

Figure 24: Light Conditions with Street Lights Off

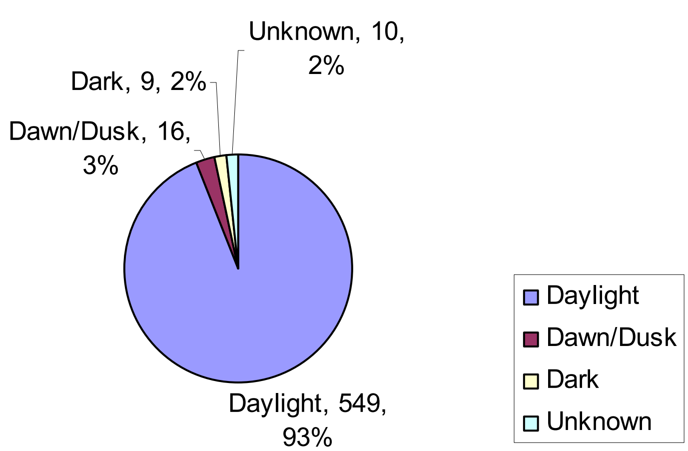
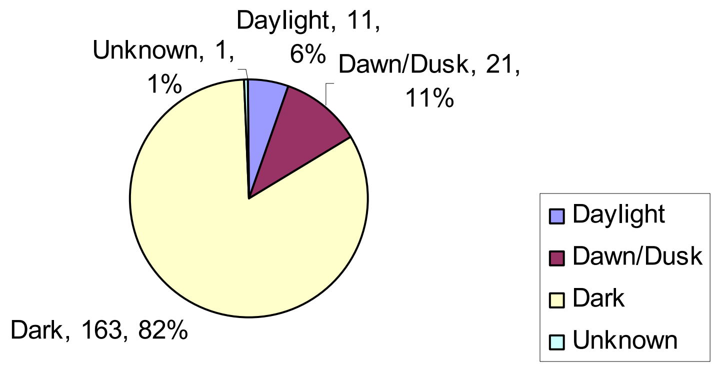


Figure 25: Light Conditions with Street Lights On



Comparisons with Earlier Studies

Outlined below are some of the most significant changes or similarities from previous years. The comparisons are limited because some information was not collected or analyzed in previous studies. All 2000 to 2002 data are described in greater detail in earlier sections of this report. Unfortunately, analyzing trends over time is difficult since there has been an 18-year gap between the 1979 and 1997-1999 reports. Nonetheless, the changes and similarities provide some valuable insight into the nature of bicycle collisions.

Bicyclist Age and Gender

Bicyclists involved in the District of Columbia crashes are older than previous studies (Table 6). In 1979, 67 percent of bicyclists involved in a collision were between the age of 10 and 24 and 87 percent were between the age of 10 and 34. In contrast, in 2000-2002, only 34 percent of involved cyclists were between the age of 10 and 24, and only 60 percent were between the age of 10 and 34. The 35 to 54 age group accounted for 28 percent of all collisions, while it only accounted for 6 percent in 1978 and 4 percent in 1979.

Table 6: Age of Involved Cyclists

Age Group	1978	1979	2000-2002
10-24	69%	67%	34%
25-34	14%	20%	26%
35-54	6%	4%	28%

The gender of those involved in bicycle crashes has remained consistent. In 1978, 85 percent were males; in 1979, males represented 90 percent; and, in 2000-2002, males made up 85 percent of those involved in bicycle crashes (in 1997-1999, male bicyclists were involved in 89 percent of reported collisions).

Injuries

The percent of crashes involving injuries has not changed much.[14] In 1978, 89 percent of all crashes resulted in injuries; in 2000-2002, about 82 percent of crashes caused injuries.

Hit-and-Runs

Hit-and-run crashes have also remained relatively constant. In the 1978 and 1997-1999 studies, they accounted for 16 percent of all bicycle crashes; in 2000-2002, they comprised 13 percent of all crashes.

[14] As described earlier in this study, collision studies using police crash report data tend to over represent injuries due to the low likelihood of reporting non-injury crashes.

Crash Location

Table 7 displays the percentage of crashes per political ward over the course of three study periods. In 1978, the bicycle crashes per ward were fairly evenly distributed. Within the 6 year period of 1997-2002, however, wards 1 and 2 have contained a large percentage of city bicycle collisions (over 50 percent in both cases).[15]

Table 7: Bicycle Collisions in City Wards—Percent of Total Collisions

Ward	1978	1997-1999	2000-2002
1	14%	21%	18%
2	19%	47%	37%
3	9%	6%	5%
4	14%	6%	6%
5	11%	5%	8%
6	12%	8%	14%
7	11%	4%	6%
8	9%	4%	4%

Season

In 1978, bicycle collisions had a more marked seasonal distribution. This is not as prevalent in the years 2000-2002. In 1978, 19 percent of collisions occurred during the fall, only 4 percent during winter, 24 percent during spring, and a full 54 percent during the summer months. For the years 2000-2002, however, 26 percent each took place during the spring and fall, 12 percent in the winter, and 36 percent in summer.

Weekday Rush Hour Bicycle Collisions

The percentage of weekday rush hour bicycle crashes has remained relatively stable; however, mornings now account for a higher percentage of collisions. In 1979, 47 percent of the weekday bicycle crashes occurred during the morning (6:30 am to 9:30 am) and evening (3:30 pm to 6:30 pm) rush hours; in 2000-2002, 42 percent took place during rush hours. In 1979, only 8 percent of the collisions happened during the morning rush hours. In 2000-2002, the morning accounted for 15 percent of bicycle crashes.

[15] The 1979 report only mentions the percentage of crashes in wards 1 and 2—24 percent and 14 percent, respectively.

Data Limitations and Recommendations for Next Steps

Data limitations can be divided into two main areas—lack of exposure data and problems with the Form PD-10 used by police to report collisions. Recommendations for next steps can also be grouped into (1) needs for improved information; (2) additional GIS research and analysis; (3) enforcement and engineering; and (4) training, education, and public involvement.

Data Limitations

Lack of Exposure Data

The fact that many collisions occur during rush hours is most likely due to the fact that many bicycle trips take place at this time. The DC Bicycle Program has limited count data for rush hours at selected points throughout the city, and longer and more frequent counts are necessary before making any assumptions of risk. Additional 'exposure data' (i.e., how many bicyclists are exposed to traffic and the risk of a crash) would be helpful in analyzing high crash locations.

Form PD-10 Issues

The Police Department's PD-10 form contains about 70 fields for incident-related information and must be filled in by hand. Many forms are not complete or contain insufficient information. Some of the more prevalent problems are noted below (with some suggestions for ways of addressing the problems):

- Missing information: Some fields were left blank (e.g., no intersection name or incorrect data given for a record). Something should be written in each field (e.g. not applicable or unknown) so users of the data will not question whether the section was simply disregarded. Boxes could be included next to the section for officers to mark not applicable or unknown responses.
- Incorrect street identification (e.g. using St. instead of Ave.) or street misspellings.
- Inadequate location description information (e.g., FBIs-for freeway, bridge or interchange, with no mile-marker number to note the location; or, listed street intersections that do not exist-for example, 7th St and 1st St, which run parallel to one another).
- Collisions marked as occurring "off-street" have no additional location information provided in the PD-10 (e.g., on sidewalk, driveway, parking lot, alley, median, curb, other-please define).
- There is a need to differentiate and define the differences between those crashes occurring at mid-block and those occurring at an intersection (i.e., mid-block is greater than 25 feet from an intersection).
- The PD-10s need consistent and clear differentiation between bike and pedestrian accidents (i.e., bike accidents are sometimes characterized as 'pedestrian' accidents under 'type of accident')

- "Other" categories are used frequently, but often not specified by the officers. For instance, in the "contributing circumstances" fields, the large percentage of "other" (without specification) significantly affects the results.
- PD-10s do not include all information that might be relevant to bicycle crashes, such as whether the cyclist was wearing a helmet and, at night, whether the bicycle had lights.
- PD-10s (and TARAS) is not capable of handling multiple contributing circumstances (i.e., officers can only mark one circumstance per vehicle involved). For instance, in one crash the bicyclist was cited, under the heading sobriety, "Had been drinking and obviously drunk." However, under the heading contributing circumstances the cyclist violation was listed as "pedestrian right of way." The contributing circumstance, should also have included, "alcohol influence."

Recommendations for Next Steps

Improved Information

- Future crash analysis should be performed on an annual basis. This and the previous tri-annual report tend to average out the results. Annual reports would provide a clearer representation of the data.
- Define specific categories to be included in each report. For instance, each report should contain identical age groupings and time groupings to make them comparable over time. The author chose groupings from national agencies—FHWA and U.S. Census Bureau—to ease comparison between national studies and the District and facilitate data importation.
- Improved data sharing between the DC MPD and other police departments with jurisdiction over roads located within the District of Columbia (and more consistent collection methods) would ensure that all reported incidents occurring in the District are included in statistical analyses. The DC MPD (or DDOT) should make efforts to obtain crash information from the National Park Police, the National Capitol Police, and military police within city boundaries.
- Future studies should integrate bicycle count data with other information such as motor vehicle volume, number of lanes, lane width, speed limit, number of curb cuts, presence or lack of sidewalks, time of day, day, month, bike lanes, roadway functional classifications (e.g. residential, collector, arterial, etc.).[16]
- Future studies should classify collisions using Cross-Fisher typologies or the Pedestrian & Bicyclist Crash Analysis Tool (PBCAT) crash types.
- Develop an alternative method for voluntarily reporting collisions, other than contacting the police. This would provide information on those crashes that do not involve a motor vehicle, that occur off the roadway, or result in minor injuries.

[16] The DC Bicycle Program has begun to collect this type of information. For example, in preparation for the striping of bike lanes on Garfield St, NW between Cleveland Ave and Massachusetts Ave, bicycle counts, motor vehicle volume, and speed counts have been conducted. After the bike lanes are installed, the counts will be repeated to determine if the bike lanes have increased bicycle volume, and the impact on motor vehicle speeds.

Additional GIS Research and Analysis: Mapping of Crash Locations

- Use GIS to determine if roadway functional classifications (e.g. residential, collector, arterial, etc.) have a statistically significant effect on the type and frequency of collisions.
- More accurate data collection methods at the time of the incident would improve accuracy and simplify the mapping process. A hand-held device, preferably with GPS capability, would increase the speed of incident reporting and improve location information. Currently, it takes more than a year for District staff to enter data from the PD-10 forms into a database. Such devices could have built-in forms and drop-down menus to guide officers and make filling in fields with proper information easier. For example, if an officer selected 'bicycle crash,' additional bicycle specific questions would appear. These devices could then be linked to a central DC GIS database system, automatically providing geographic coordinates and other data for the incidents (DDOT, 2002).
- Similarly, map the bicycle facilities (bike lanes, signed bike routes, shared off-road trails, etc.) existing during the year(s) of analysis and determine if these have a statistically significant effect on the type and frequency of collisions.[17]
- Use GIS to map collisions by Advisory Neighborhood Commissions (ANCs). This information would be useful in identifying ANCs (along with the larger ward groupings) that have high incidences of bicycle crashes.
- Using GIS, perform a grid or point-pattern analysis. Point-pattern analysis is commonly used in epidemiology for exploring spatial variation in disease risk (Gatrell et al., 1995). Using a GIS, the District's 10-mile northeastern edge would simplify overlaying an equal interval grid and search for variation and clustering of bicycle collisions.[18]

Enforcement and Engineering

- Enforcement should be targeted to those times (peak hours), locations (Wards 1 and 2), and contributing circumstances that resulted in the highest number of collisions.
- The City should place automated speed and red light cameras in locations with high numbers of crashes.
- Evaluate intersections with high frequencies of collisions for possible safety modifications.
- Continue to provide cyclist facilities (i.e. bike lanes, wide curb lanes, signed bike routes) that increase awareness of the presence of cyclists and enhance safety.

Training, Education, and Public Involvement

- Initiate a program of police training whereby the police may become better aware of the purposes of the crash reports and their proper coding. This will better insure that all

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[17] Moritz (1998) found that crash rates were significantly lower on streets either signed as a bike route or having bike lanes than all other facility types.

[18] The District's diamond outline could be rotated 90 degrees counter-clockwise or the grid could be rotated 90 degrees clockwise to maximize the number of equal-interval analysis cells.

portions of the accident reports are completed, that the reports are properly coded, and that information, such as narrative, is more clearly expressed (Angelis et al., 1979).

- Gear additional education and training towards cyclists aged 25 to 34 years. In addition, all cyclists need to be reminded of the importance ob obeying traffic laws.
- Because a majority of the involved motorists were not registered D.C. drivers, driver education, training, and tests for licensing should be regional in scope. These programs should educate drivers regarding cyclists' rights as well as effective driving techniques when encountering cyclists.
- Males are much more likely to ride bicycles than females (about four times as likely); therefore, females represent a large pool of potential cyclists. While women are more likely than men to engage in trip-chaining behavior, which usually necessitates an automobile, outreach programs should encourage more women to bicycle.
- Promote greater ANC involvement in bicycle crash safety awareness by distributing the crash reports to ANC commissioners (Angelis et al., 1979). Each of the city's 37 ANCs has a commissioner who represents the neighborhood's interests to various District government agencies, the Executive Branch, the Council, and Federal agencies. This "grassroots" entity would be a good forum to alert residents to hazardous locations for bicyclists.

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